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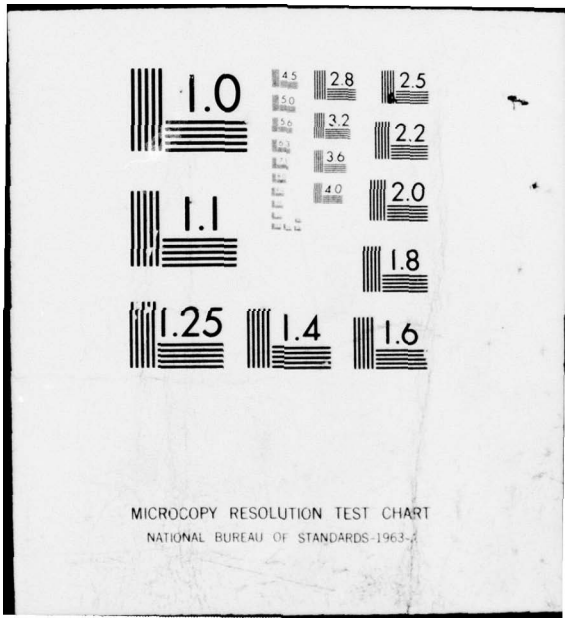
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EVALUATION OF LUBRICATING COMPOSITES FOR THE M16A1 RIFLE

GEORGE P. MURPHY, JR.
BERNARD J. BORNONG

FEBRUARY 1976

TECHNICAL REPORT

RESEARCH DIRECTORATE

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3. Weapon Malfunctions
4. Weapon Firing Rate
5. Lubrication

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A previous firing test made on one M16A1 rifle indicated that a combination of self-lubricating composites applied to the bolt carrier group and a solid-film lubricant coating applied to the upper receiver tracks could reduce malfunctions and maintenance time as compared with conventional lubrication. A follow-up test was carried out with five composite-lubricated rifles and one MIL-L46000A lubricated rifle as a control. The composite inserts, though slightly different in shape, were placed in the same areas as for the original test. The test on

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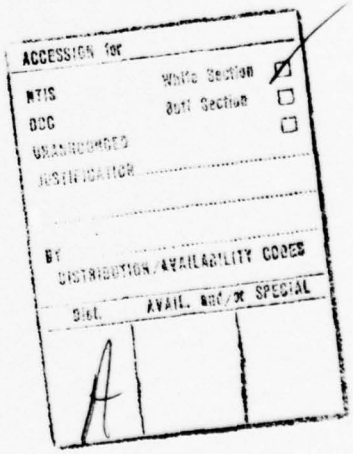
the five composite-lubricated rifles had an average of six malfunctions to with one in the original test. Three of the rifles were terminated before 10,000 rounds because of the fracture of the inserts. In one of these rifles the bolt se sealing ring insert broke; this action caused the sealing ring to break. In the other two composite-lubricated rifles removed from test, the inserts in the cam path area fractured and fell out because, when the insert hole was machined, it broke through the cam path wall. The impact of the cam pin against the exposed portion of the insert eventually caused cracking. Nevertheless, there tests have demonstrated the feasibility of the use of the self-lubricating inserts. However, care must be exercised to insure that the inserts.fit properly and are backed up with sufficient high-strength material.

CONTENTS



OBJECTIVE

The objective of this program was to evaluate self-lubricating composites for application to the M16A1 rifle to reduce maintenance and to improve reliability and durability.

BACKGROUND

A previous report by Martin and Murphy[1] indicated that a self-lubricating composite applied to an M16A1 rifle reduced its malfunction rate compared with that obtained during firing tests on unlubricated rifles and rifles with MIL-L-46000 Lubricant. The composite was a metal matrix of molybdenum, niobium, and copper with molybdenum disulphide as the solid lubricant. This material was applied as inserts in the bolt carrier tracks, bolt carrier key, and bolt sealing ring area of the gas cylinder.

Since the previous results were based on the firing of only one rifle containing the self-lubricating composite inserts, firing tests on several additional rifles lubricated with the composite insets were considered necessary to verify the original results.

APPROACH

The bolt carrier of five M16A1 rifles were modified by placement by self-lubricating composites in the bolt carrier tracks, in the bolt carrier key, and in the gas cylinder wall in contact with the bolt sealing rings. These rifles, along with a rifle lubricated with MIL-L-46000 as a control, were fired for a maximum of 10,000 rounds, and the malfunctions and firing rates were determined.

PROCEDURE

The bolt carrier track, bolt carrier key, and bolt carrier in the gas cylinder wall in which the bolt sealing rings made contact, were drilled to hold the self-lubricating composites. These machined areas are shown in Figures 1, 2, 3. An insert is already in place in the bolt carrier and in the carrier key. Note, in Figure 1, that the insert hole at the far left of the upper track in the cam path area broke through the wall of the cam path. The consequences of these holes in the cam tracks on the test results will be considered later in this report, in the Results and Discussion section. At the time that these holes were discovered, funding and time limitations would have lead to decision to terminate the test rather than re-do a new set of bolt carriers. A decision was made to proceed with the test after the composite inserts were filed flush with the cam track surfaces.

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1. P. Martin, Jr., and G. Murphy, Jr., General Thomas J. Rodman Technical Report R-TR-75-005, "Application of Lubricating Composites to the M16A1 Rifle." December 1974.

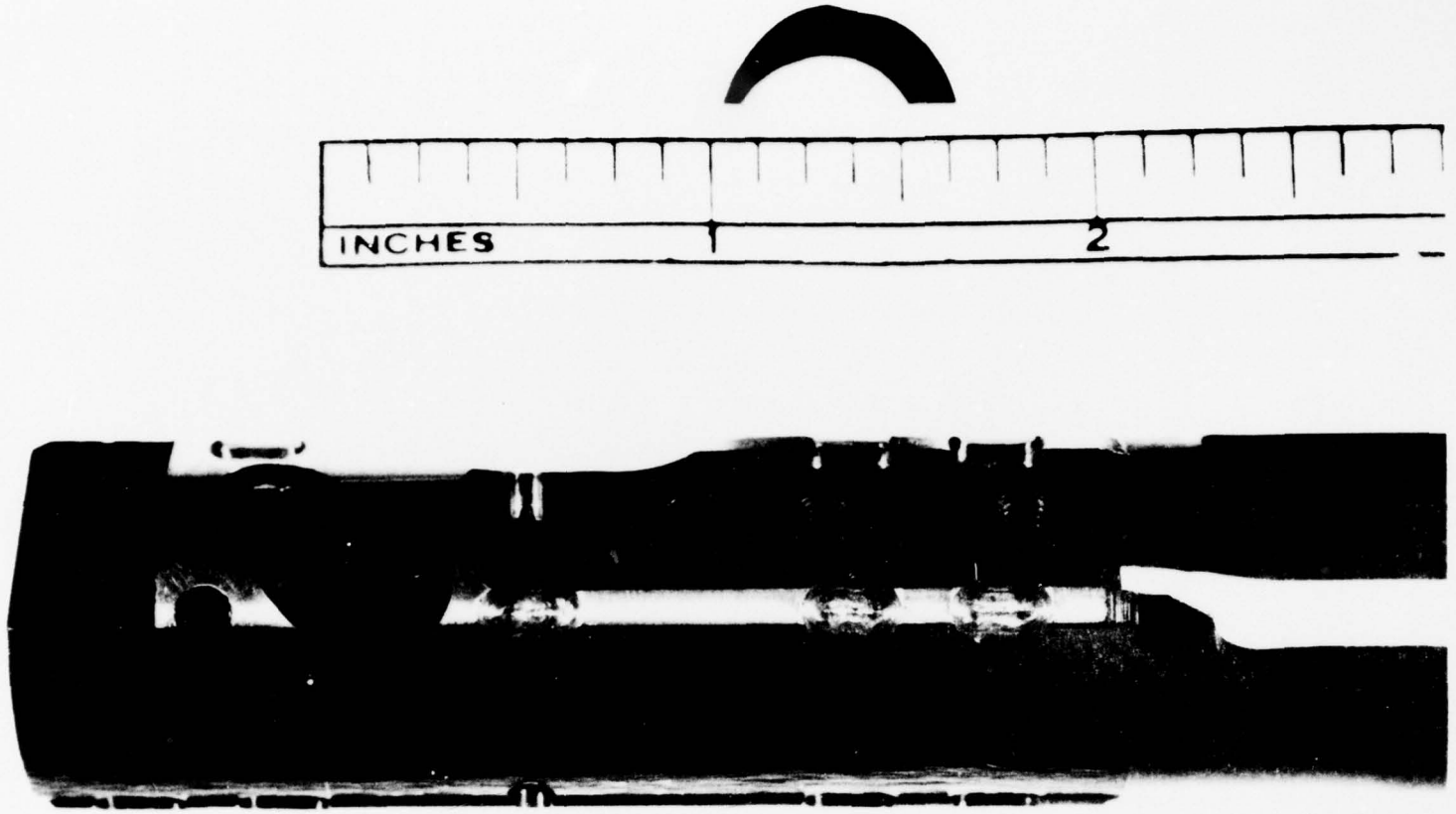

Figure 1. Left Side View of Bolt Carrier Showing Holes for Composite Inserts.

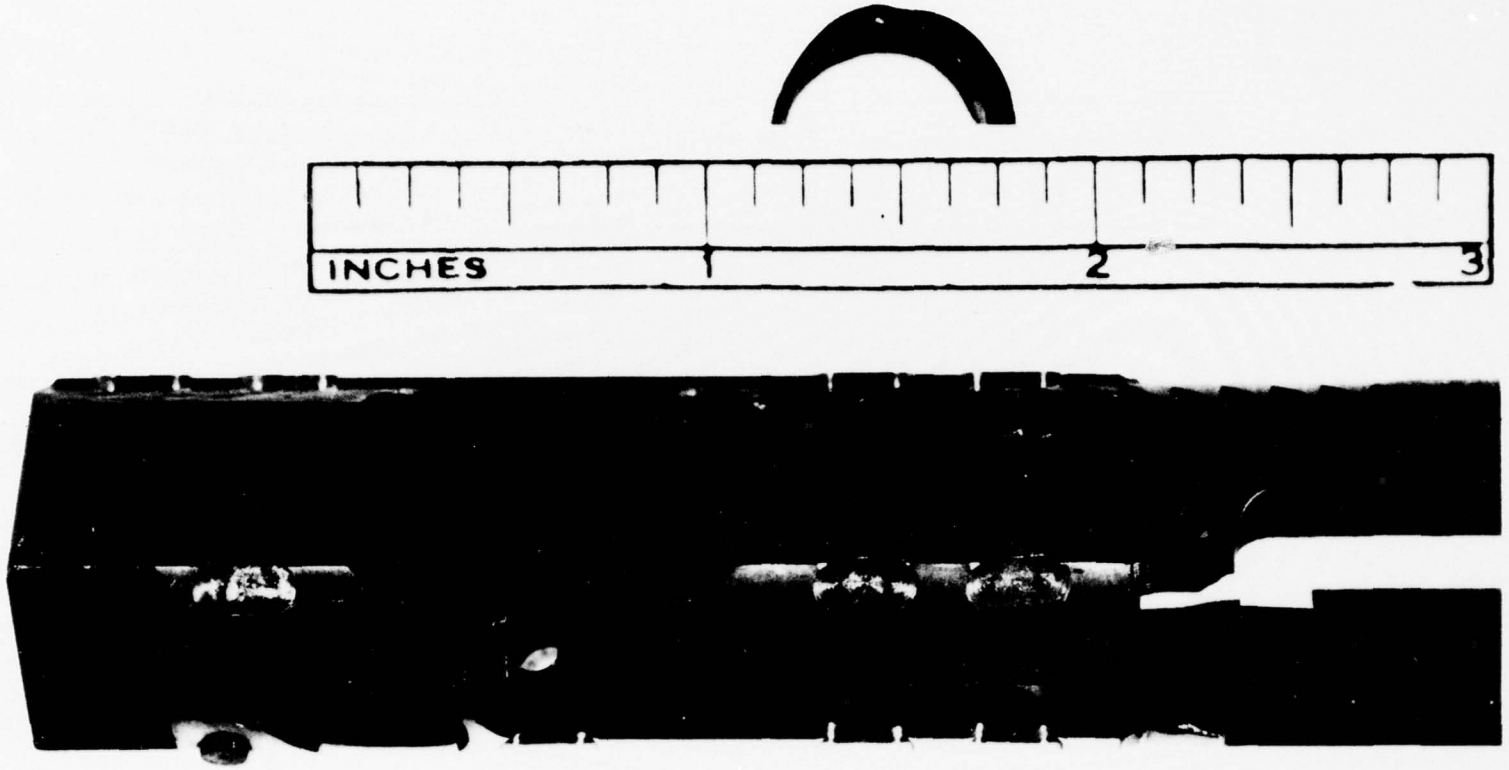

Figure 2. Right Side View of Bolt Carrier Showing Holes of Composite Inserts.

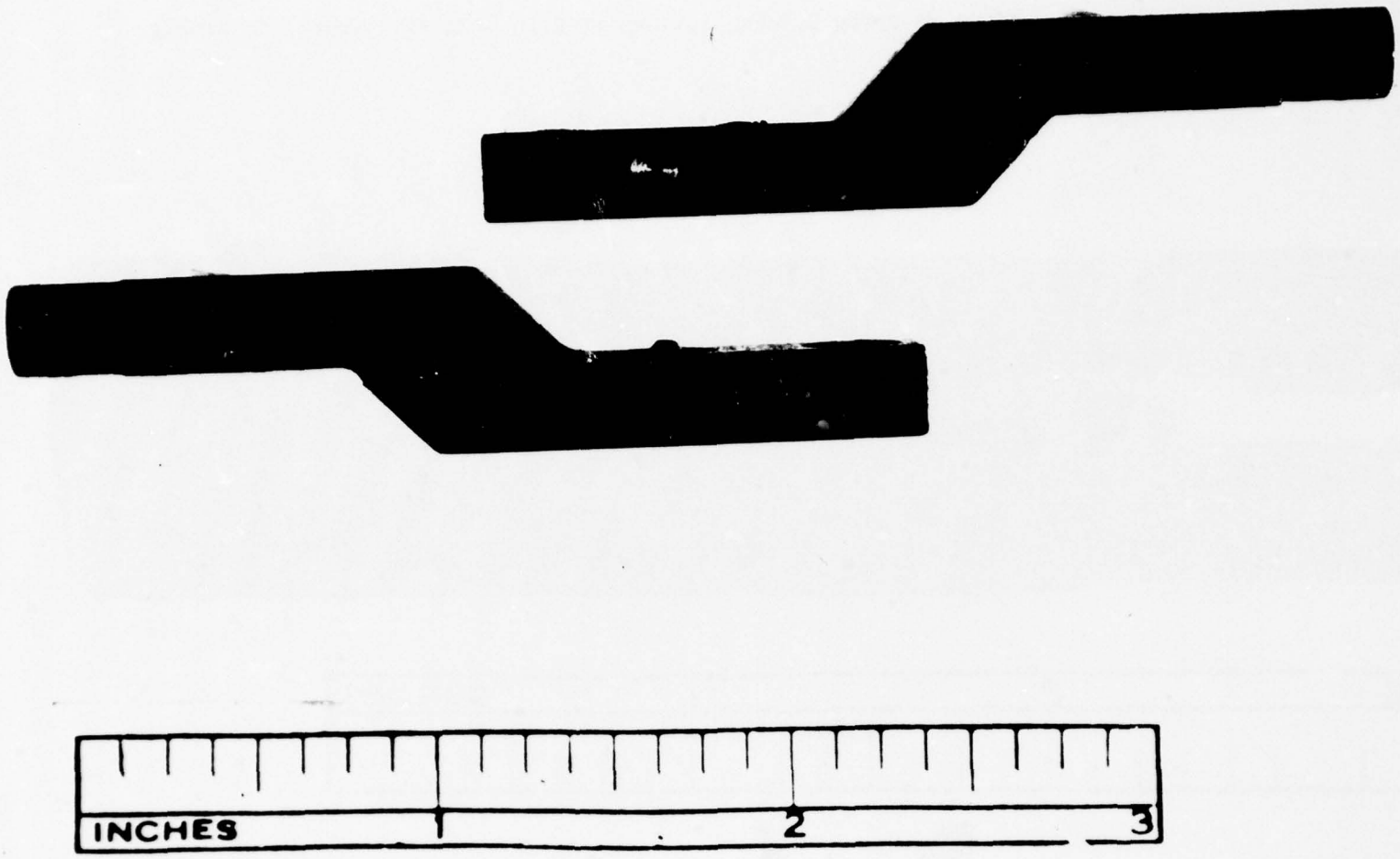

Figure 3. Side View of Bolt Carrier Key Showing Hole and Composite Insert in Place.

The shape of most of the composite inserts was changed from cylindrical in the first test to an oblong shape, as shown in Figure 1. The purpose of this change in shape was to provide increased surface area to decrease the bearing load on the composite and to make more of the composite available for lubrication.

The types of composite inserts used are shown in Figure 4. These inserts were glued in place with epoxy resin, as shown in Figures 5 and 6. The composite inserts were then ground down until they protruded .005 inch above the surfaces to which they were applied. The appearance of the bolt carriers after this grinding process is shwon in Figures 7 and 8.

After the inserts were ground down, the five composite rifles and the control rifle were cleaned. The control rifle was lubricated normally with MIL-L-46000A Lubricating Oil, Semi-Fluid (Automatic Weapons). The six rifles were tested by personnel of the Weapons Test Division (SARRI-RLE-T) following this firing test plan:

A. Firing Test Schedule.

Fire according to the following schedule with five 20-round magazines loaded in sequence without any delays:

a. Fire 100 rounds, automatic.

b. Cool rifle to ambient temperature (maximum, 1 hour).

c. Fire 100 rounds, semi-automatic (1 second between rounds).

d. Cool rifle to ambient temperature (maximum, 1 hour).

e. Repeat firing sequence a through d until 10,000 rounds have been fired or failure of the weapon to fire occurs.

B. Instrumentation.

Determine rate of fire (rounds per minute) during step a given above, preferably on the first magazine.

C. Special Instructions.

a. Using ball ammunition, fire the first 5,500 rounds from a firing jack. Using a mixture of 4 ball to 1 tracer, fire the next 500 rounds from the firing jack. Using amixture of 4 ball to 1 tracer, fire the remaining 4000 rounds from the shoulder.

b. Replace any parts that break during firing, and continued the test.

c. Assess all malfunction as to type and probable cause.

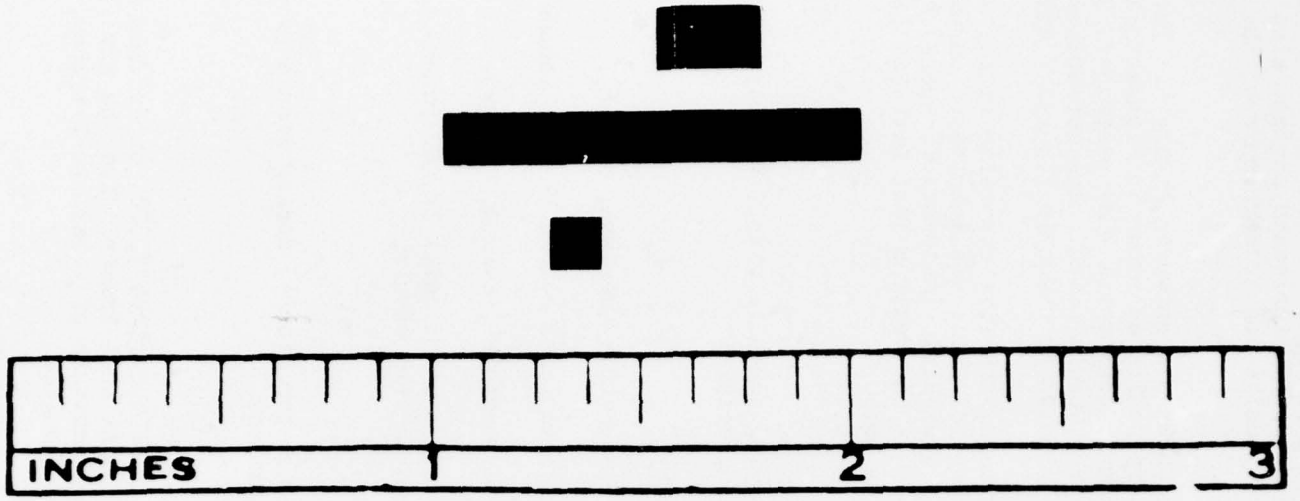

Figure 4. Types of Self-Lubricating Composites Used.

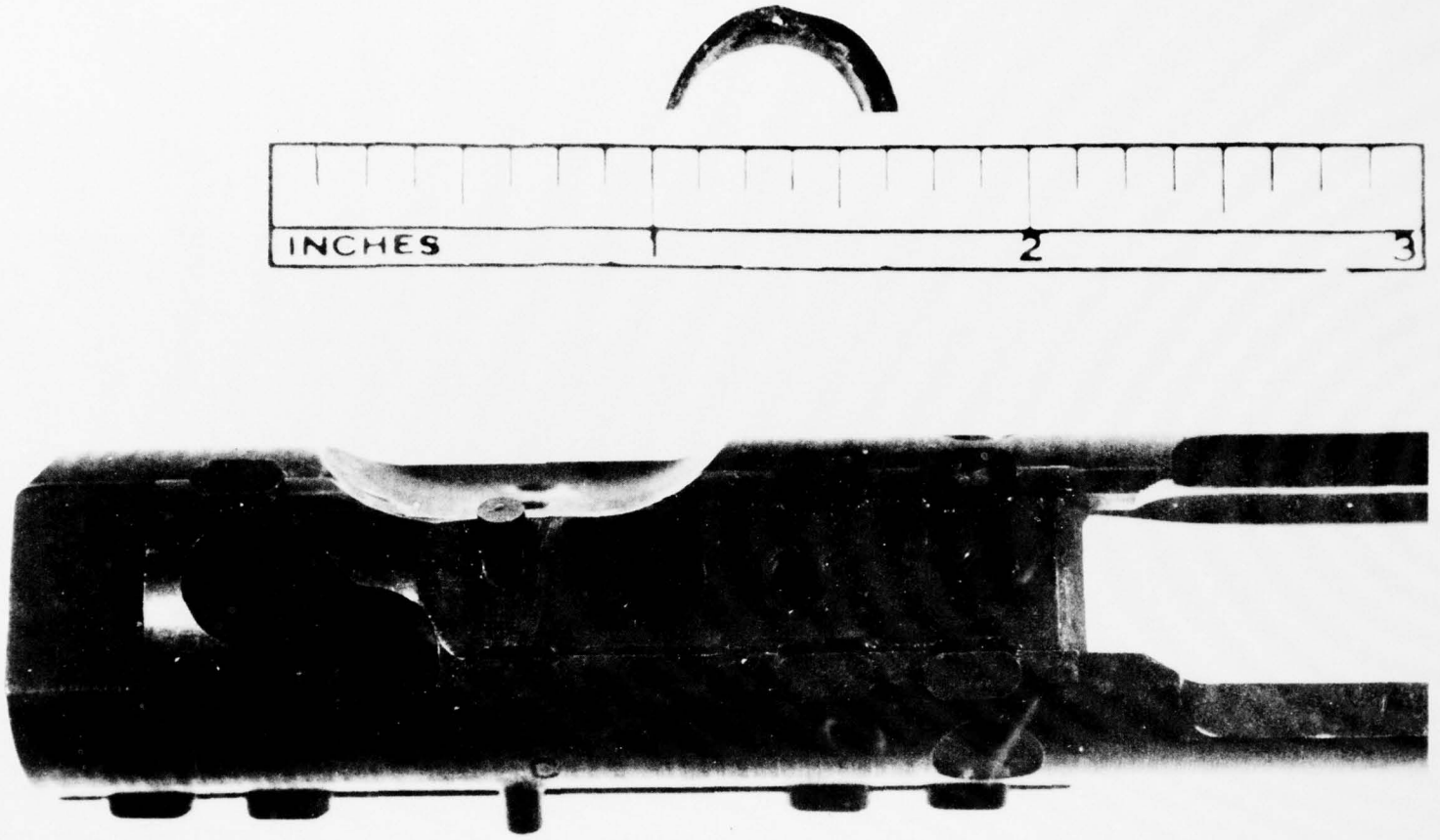

Figure 5. Left Side of Bolt Carrier Showing Inserts in Place.

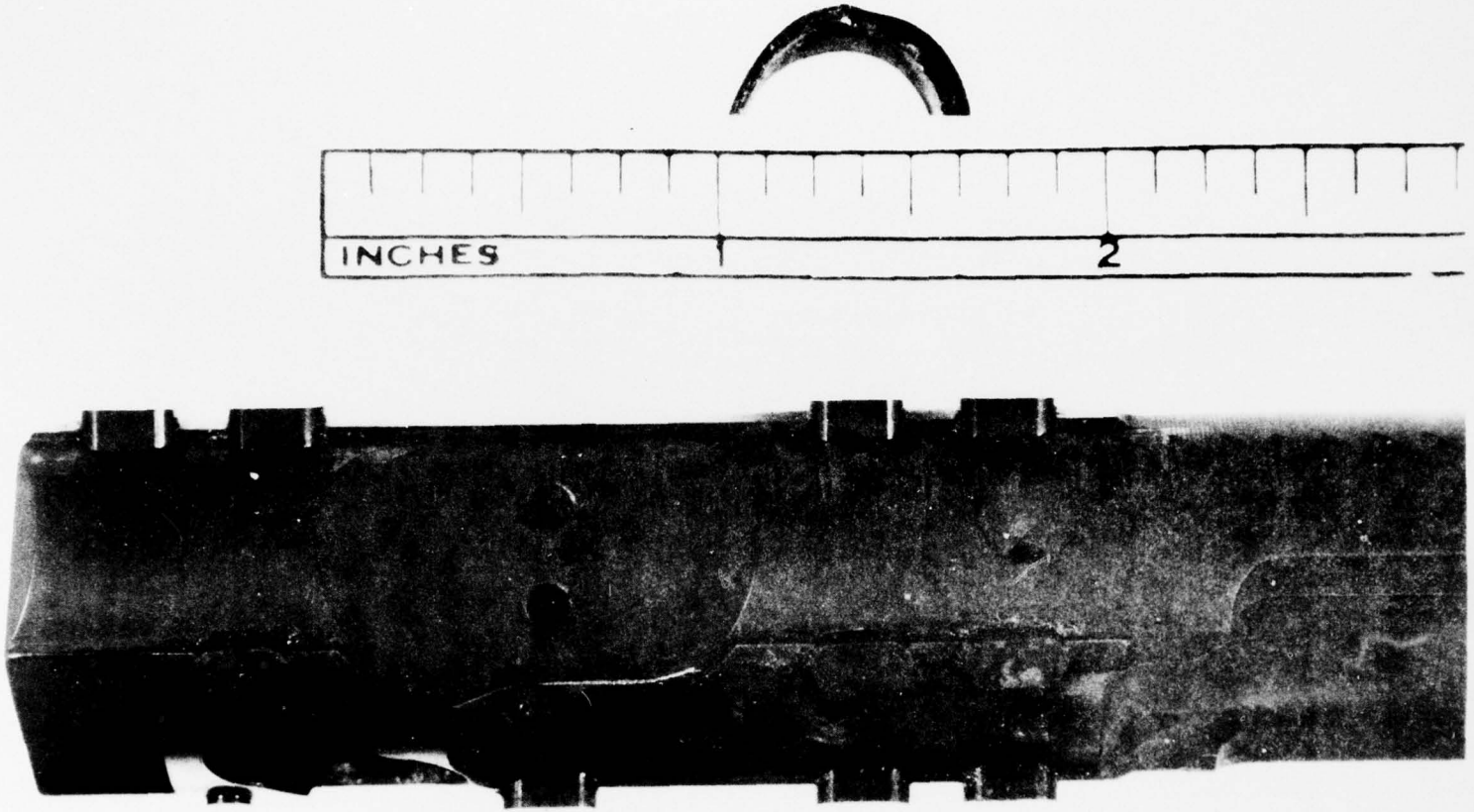

Figure 6. Right Side of Bolt Carrier Showing Inserts in Place.

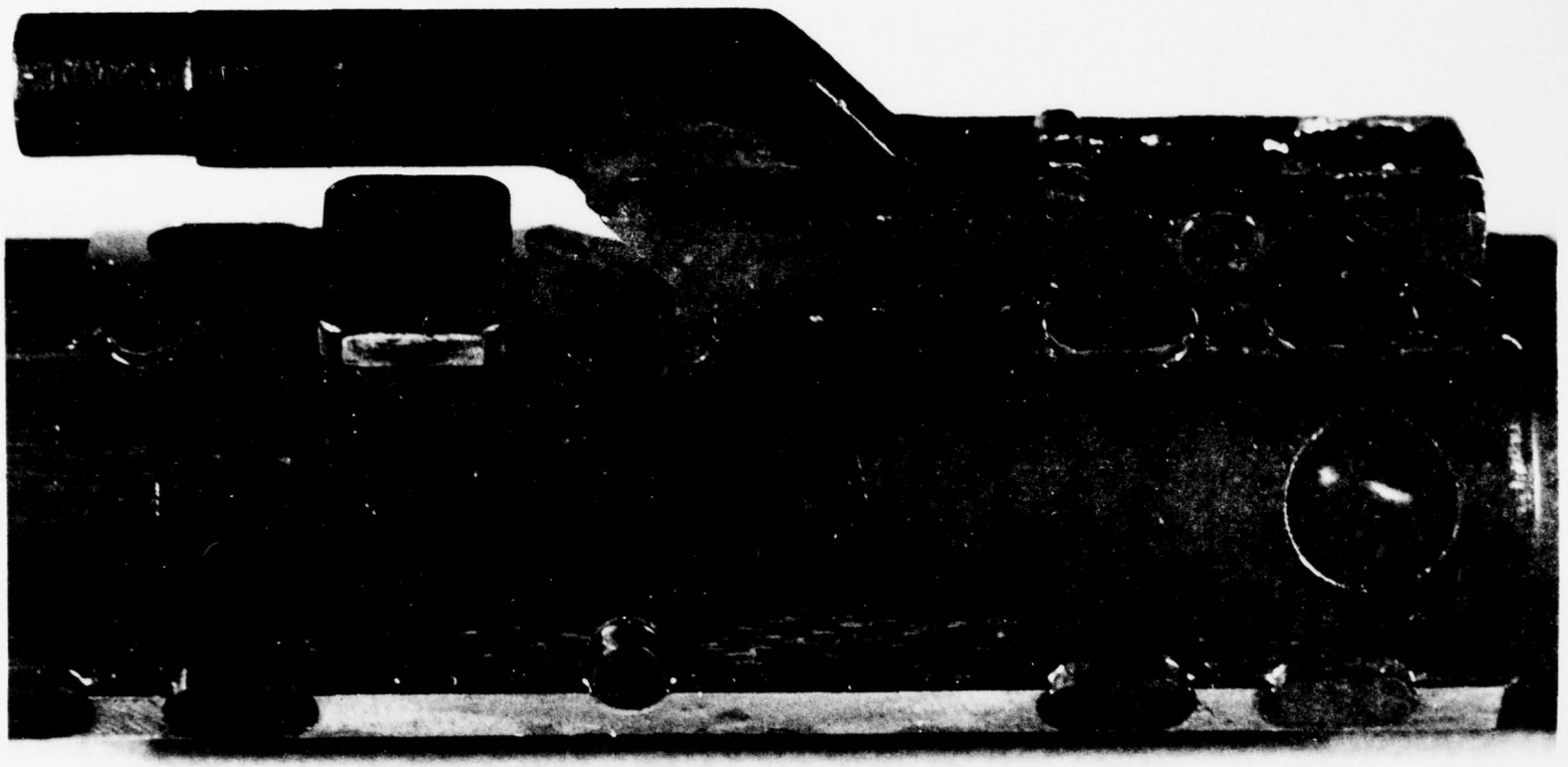

Figure 7. Left Side View of Bolt Carrier With Inserts Ready for Test.

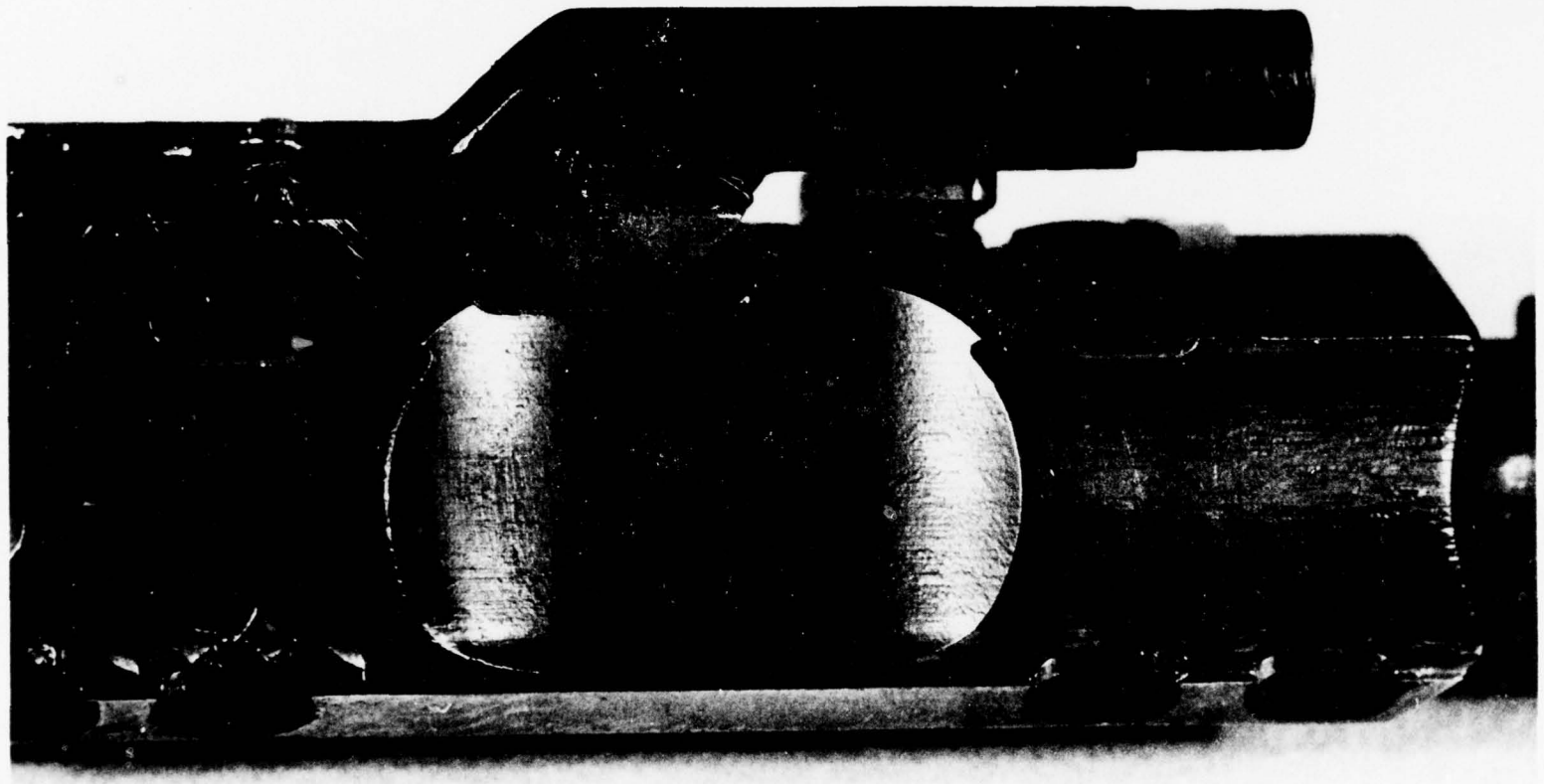

Figure 8. Right Side View of Bolt Carrier With Inserts Ready for Test.

d. Terminate the test when a malfunction rate of 25 per 100 rounds occurs.

e. Do not clean or lubricate the weapons during the test.

RESULTS AND DISCUSSION

Two table designations are referred to in the body of this report, i.e., those that have a prefix A such as Table A-1 and those that do not have a prefix such as Table 1. Those tables with the prefex A that are found in Appendix A give the raw individual malfunction and firing rate data. Those tables without the prefix A provide an analysis of the data given in the appendix.

The firing rate data are given in Table A-1 in appendix A. The raw data were averaged in 1000-round intervals, and these averages are given in Table 1. The overall average firing rate of four composite rifles Nos. 1, 2, 3, and 5 is 809 rounds per minute, which is in agreement with the 800-round-per-minute figure for the original composite rifle test. Rifle No. 4 was excluded from the average because of the short time that it was in the test. Like the original composite rifle test, the firing rate for each of the 4 composite rifles was relatively constant.

Note that Rifle No. 6, lubricated with MIL-L-46000A, had an average firing rate of 912 rounds per minute, which is much higher than the 761-round-per-minute value for the MIL-L-46000A-lubricated rifles obtained in the previous firing test. The high firing-rate of this rifle is unexplainable since it was prepared for firing in the same manner as the rifles in the previous test. Futhermore, the average firing rates of the composite-lubricated rifles used in the two tests were essentially the same.

The malfunction type and number given in Tables A-2 to A-7 are summarized in Table 2; of the

Table 2

SUMMARY OF MALFUNCTIONS BY TYPE

	COMPOSITE-LUBRICATED					MIL-L-46000A LUBRICATED
Malfunction Type *	Rifle No. 1	Rifle No. 2	Rifle No. 3	Rifle No. 4	Rifle No. 5	Rifle No. 6
FF-FBL	1	3	10	0	6	0
FFr-L.I.	5	27	3	1	13	5
FFr-U	0	0	0	0	0	2
FX	0	6	0	1	0	0
FJ	0	0	0	9	0	0
FF-BOB	0	1	0	0	0	0
FF-SB	0	0	0	1	0	0
TOTAL	6	37	13	11	19	7

* See page 18 for identification of Malfunction types.

TABLE 1

AVERAGE FIRING RATE FOR 1000-ROUND INTERVALS

ROUNDS FIRED	FIRING RATE (ROUNDS PER MINUTE) COMPOSITE-LUBRICATED RIFLES					MIL-L-46000A Lubricated
	Rifle No. 1	Rifle No. 2	Rifle No. 3	Rifle No. 4	Rifle No. 5	Rifle No. 6
1000	760	760	770	710	790	875
2000	775	805	795	750 (2)	840	920
3000	810	845	840		875	970
4000	820	835	840		850	920
5000	820	815	840		870	935
6000	810	820	840		850	910
7000	770 (1)	780	785		810	880
8000		760	785		805	890 (4)
9000		790	805		820 (3)	
10000		775	810			
OVERALL AVERAGE	795	798	811	730	834	912

1. Test terminated at 6903 rounds.
2. Test terminated at 1836 rounds.
3. Test terminated at 9095 rounds.
4. Test terminated at 7904 rounds.

malfunction types, only the first three namely FF-FBL, FFr-LI, and FFr-U were considered to be caused by the lubrication of the bolt carrier group.

The malfunctions due to the lubrication of the bolt carrier group will be discussed separately for each rifle. With respect to the composite-lubricated Rifle No. 1, 6 malfunctions occurred. Malfunction FF-FBL was due to the bolt carrier group. With respect to the 5 FFr-LI malfunctions, 3 were due to bad ammunition and were not considered to be bolt-carrier related. The other 2 occurred shorthly before the test of Rifle No. 1 was terminated at 6903 rounds. The rifle was removed from the test at this point because the insert adjacent to the cam path had fractured. The broken insert caused the last two FFr-LI malfunctions. Because these two malfunctions might not have occurred if the insert had not broken, they were not considered lubrication malfunctions. The breakage occurred because the insert was exposed to the impact of the cam throught the hole made in the cam path wall during machining. Therefore, Rifle No. 1 had only one malfunction due to the bolt carrier group.

Rifle No. 2 completed the full 10,000-round test, and had three FF-FBL and 27 FFr-LI malfunctions. The three FF-FBL were bolt-carrier related. However, 26 of the 27 FFr-LI were due to weak or broken hammer springs that were replaced twice, after 7461 and after 8201 rounds. The remaining FFr-LI was due to a broken extractor spring. Therefore, Rifle No. 2 had 3 malfunctions due to the bolt carrier group.

Rifle No. 3 also completed the full 10,000-round test, and had 13 malfunctions: 10 FF-FBL and 3 FFr-LI. The 10 FF-FBL were relative to the bolt carrier group. The 3 FFr-LI all occurred when tracer ammunition was used; they occcurred late in the test and were caused in part, by a combination of heavy carbon deposits on the firing pin. In addition, the tracer rounds were more difficult to ignite than the ball rounds. The light indent problem did not occur with the ball ammunition. All 13 malfunctions of Rifle No. 3 are attributed to the bolt carrier group.

Rifle No. 4 had only one malfunction during the short time that it was in test. The test on this rifle was terminated after 1836 rounds because of a broken insert in contact with the bolt sealing ring. This broken insert left an exposed machined groove which caused the sealing rings to break. The one malfunction was due to this broken insert. Thus, no malfunctions occurred that were considered to be due to the lubrication of the bolt carrier group. This was the only rifle in which the bolt sealing ring insert broke.

Rifle No. 5 had 19 malfunctions: 6 FF-FBL and 13 FFr-LI. The test on this rifle was terminated after 9095 round because the insert in the cam path area was broken out. The 6 FF-FBL were due to the bolt carrier group, and 8 FFr-LI were due to the bolt carrier group the remaining 5 FFr-LI occurred near the end of the test and were caused by the broken insert. This rifle therefore, had 14 malfunctions that were considered to be due to the bolt carrier group.

The five rifles had 31 malfunctions, or an average of 6 per rifle. This was a somewhat higher malfunction rate than that of the one malfunction for the composite-lubricated rifle used in the original test. However, this is still considerably lower than the 20 and 100 malfunction per rifle for the MIL-L-46000A and the unlubricated rifles respectively, used in the first test.

Although Rifles Nos. 2 and 3 completed the 10,000-round test, the composite insert in the cam path area had cracked. In Figure 9, the bolt carrier of Rifle No. 3 is shown at the end of the test with the cracked insert. Therefore, with the exception of Rifle No. 4, which was in the test for only a short time, the composite insert in the cam path area, at which the cam path wall was broken through during machining, either fell out or broke off, or was cracked. The effect of this on the test results is difficult to assess. The exact time at which these inserts cracked could not be determined; however this cracking could have occurred very early in the test. Some malfunctions undoubtedly occurred because of these cracked inserts and not because of any lubrication deficiencies. In spite of the difficulties encountered with the inserts in this one area of the carrier cam, the 6-malfunction rate per composite-lubricated rifle is considered very good.

The MIL-L-46000A-lubricated rifle (Rifle No. 6) had malfunctions: 5 FFr-LI and 2 FFr reason unknown. All these were due to the carbon buildup which caused the firing pin to stick. This sticking of the firing pin was such that the firing pin had to be pounded out at 6705 and 7904 rounds to examine the bolt to determine the reason why the rifle would not fire. The test was terminated after 7904 rounds. However, this test could have been terminated after 6705 rounds because of the heavy carbon buildup. Thus, all the composite-lubricated rifles except Rifle No. 4 lasted longer in test than the MIL-L-46000A-lubricated rifle.

If the malfunctions for both this test and the original firing test are combined, the following malfunction rates attributable to the bolt carrier group are obtained:

(1) Composite-lubricated rifles: 0.8 per 1000 rounds

(2) MIL-L-46000A-lubricated rifles: 2.3 per 1000 rounds

(3) Unlubricated rifles: 12.8 per 1000 rounds

This test shows that the self-lubricating composite does decrease the malfunction rate even though no cleaning or relubrication is carried out. The test also shows that the self-lubricating composite tends to be brittle and will crack if it is not properly placed or if it is not backed up with sufficient high-strength material.

CONCLUSIONS

The following conclusions can be drawn from the results of this firing test:

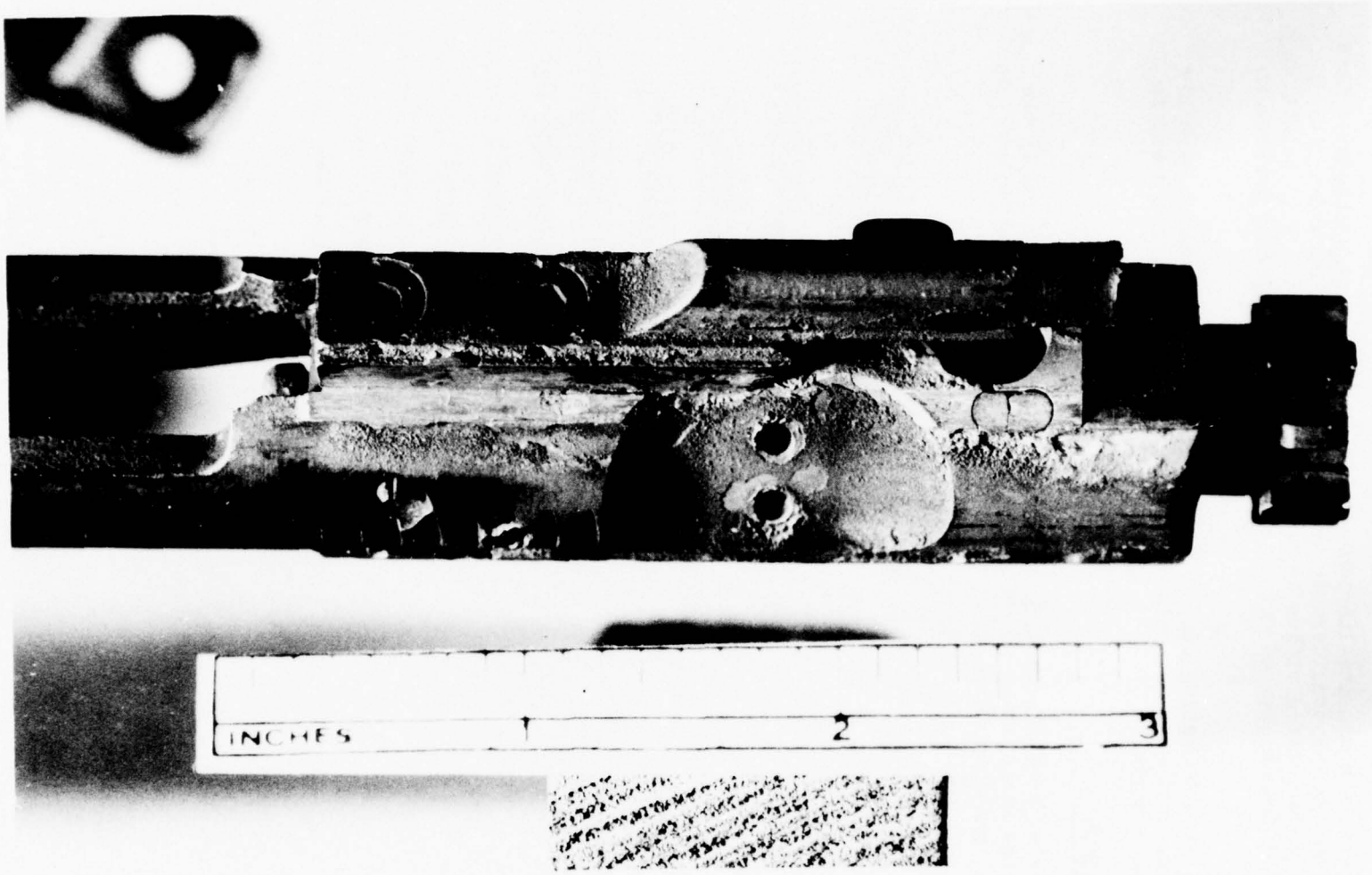

Figure 9. Bolt Carrier after 10,000 Rounds Showing Cracked Insert.

1. Although the composite-lubricated rifle had some malfunctions in this test, the number was considerably less than those that occurred with the MIL-L-46000A-lubricated rifles in the first firing test. This result confirms the feasibility of using self-lubricating composite inserts in weapons.

2. Since the lubricating composite tends to be brittle and susceptible to cracking, care must excercised in machining the insert holes and in placing the inserts.

RECOMMENDATIONS

The use of self-lubricating composites should be considered in the design of new weapons and in the solution of difficult friction and wear problems in existing weapons.

APPENDIX-TEST DATA

This appendix contains all firing test data tables. These tables are preceded by a list that identifies the abbreviations used for the various types of malfunctions that occurred during the firing test.

IDENTIFICATION OF MALFUNCTION
TYPES GIVEN IN FIRING TEST TABLES

Malfunction Type	Malfunction	Description
FF-FBL	Failure to Feed	Failure of bolt to lock
FF-BOB	Failure to Feed	Bolt over base of cartridge
FF-SB	Failure to Feed	Nose of round stubbed on barrel extension
FFr-LI	Failure to Fire	Light indent
FFr-U	Failure to Fire	Reason unknown
FX	Failure to Extract	
FJ	Failure to Eject	

TABLE A-1

FIRING RATES

ROUNDS FIRED	FIRING RATE (ROUNDS PER MINUTE) COMPOSITE - LUBRICATED					
	Rifle No 1	Rifle No 2	Rifle No 3	Rifle No 4	Rifle No 5	Rifle No 6
100	760	770	790	740	780	875
300	765	770	780	695	790	850
500	785	740	755	690	785	880
700	700	775	785	-	825	850
900	730	730	750	715	780	915
1100	735	730	760	685	775	860
1300	760	815	800	770	845	930
1500	775	820	770	765	850	920
1700	805	825	830	785	855	950
1900	800	825	820	(1)	885	950
2100	815	800	805		850	1000
2300	805	855	845		870	950
2500	775	860	845		875	975
2700	820	855	835		885	935
2900	820	845	880		885	985
3100	820	830	845		840	945
3300	805	860	840		860	945
3500	820	855	845		870	870
3700	810	820	845		860	925
3900	850	815	830		835	910
4100	815	815	835		850	915
4300	825	800	825		870	925
4500	825	820	835		935	925
4700	810	815	825		850	950
4900	825	835	875		850	955
5100	820	825	855		845	885
5300	825	850	850		870	925
5500	815	825	835		870	935
5700	785	795	830		845	910
5900	800	795	820		805	905
6100	795	800	840		860	945
6300	770	750	780		805	800
6500	755	755	755		795	900
6700	755	770	760		785	885
6900	775	775	770		805	880
7100	(2)	775	800		775	950
7300		750	765		800	855
7500		770	785		805	895
7700		730	775		810	880
7900		770	810		825	860
8100		770	775		810	(3)
8300		825	795		805	

TABLE A-1

FIRING RATES
(continued)

ROUNDS FIRED	FIRING RATE (ROUNDS PER MINUTE) COMPOSITE - LUBRICATED					
	Rifle No 1	Rifle No 2	Rifle No 3	Rifle No 4	Rifle No 5	Rifle No 6
8500		785	805		835	
8700		770	825		840	
8900		790	820		815	
9100		775	820		825	
9300		775	825		(4)	
9500		800	820			
9700		765	810			
9900		755	785			

1. No rates after 1700 rds, gun no longer in test
2. No rates after 6900 rds, gun no longer in test
3. No rates after 7900 rds, gun no longer in test
4. No rates after 9100 rds, gun no longer in test

TABLE A-2

FIRING TEST RESULTS

(COMPOSITE-LUBRICATED RIFLE NO. 1)

Malfunction Number	Malfunction Type	Type of Fire	Rounds Fired When Malfunction or Event Occurred	Remarks
1	FFr-LI	Automatic	881	Round fired the third time it was struck, due to ammunition.
2	FFr-LI	Automatic	1481	Round fired the second time it was struck, due to ammunition.
-	-	-	1900	Because of broken sealing ring in Rifle No. 4, all composite rifles were checked. Sealing ring OK; upper track inserts wearing; firing pin difficult to remove.
3	FFr-LI	Semi-Automatic	2710	Because of ammunition.
4	FF-FBL	Semi-Automatic	5901	Rifle was gymmed by hand to feed first round.
5	FFr-LI	Semi-Automatic	6701	
6	FFr-LI	Semi-Automatic	6903	Rifle taken apart. Charging handle difficult to pull back; oblong composite insert in upper right cam path area cracked in half. Rifle taken out of test.

TABLE A-3

FIRING TEST RESULTS

(COMPOSITE-LUBRICATED RIFLE NO. 2)

Malfunction Number	Malfunction Type	Type of Fire	Rounds Fired When Malfunction or Event Occurred	Remarks
-	-	-	1900	Because of broken sealing rings in Rifle No. 4, all composite rifles were checked. Sealing ring OK: Firing pin difficult to remove; Bolt carrier group carboned up.
1	FX	Semi-	3190	Malfunctions 1
2	FX	Automatic	3191	through 6 were
3	FX	"	3192	caused by broken
4	FX	"	3193	extractor spring,
5	FX	"	3194	which was replaced.
6	FX	"	3195	
7	FF-FBL	Semi-Automatic	5901	Rifle was gymmed by hand to feed first round.
8	FFr-LI	Automatic	6801	Broken extractor-spring, replaced.
9	FF-FBL	Semi-Automatic	6901	
10	FF-FBL	Semi-Automatic	6961	
11	FFr-LI	Semi-Automatic	7376	
12	FFr-LI	Automatic	7461	Malfunctions 12
13	FFr-LI	"	7462	through 15 due to
14	FFr-LI	"	7463	broken hammer spring
15	FFr-LI	"	7464	which was replaced.

TABLE A-3

FIRING TEST RESULTS
(COMPOSITE-LUBRICATED RIFLE NO. 2)
continued

Malfunction Number	Malfunction Type	Type of Fire	Rounds Fired When Malfunction or Event Occurred	Remarks
16	FFr-LI	Automatic	7681	Malfunctions 16 through 35 occurred on tracer rounds, could be due to weak hammer spring which was replaced after 8201st round.
17	FFr-LI	Semi-Automatic	7781	
18	FFr-LI	Automatic	7801	
19	FFr-LI	"	7821	
20	FFr-LI	"	7841	
21	FFr-LI	"	7861	
22	FFr-LI	Semi-Automatic	7926	
23	FFr-LI	"	7966	
24	FFr-LI	"	7970	
25	FFr-LI	"	7974	
26	FFr-LI	Automatic	8001	
27	FFr-LI	"	8021	
28	FFr-LI	"	8041	
29	FFr-LI	"	8061	
30	FFr-LI	"	8081	
31	FFr-LI	Semi-Automatic	8132	
32	FFr-LI	"	8146	
33	FFr-LI	"	8162	
34	FFr-LI	"	8182	
35	FFr-LI	Automatic	8201	
36	FFr-LI	Semi-Automatic	8340	
37	FF-BOB	Semi-Automatic	8356	
-	-	-	9600	Extractor spring replaced.
-	-	-	10000	Several days after test was completed oblong insert in upper right cam path area was found to be loose.

TABLE A-4

FIRING TEST RESULTS

(COMPOSITE-LUBRICATED RIFLE NO. 3)

Malfunction Number	Malfunction Type	Type of Fire	Rounds Fired When Malfunction of Event Occurred	Remarks
-	-	-	1900	Because of broken sealing ring in Rifle No. 4, all composite rifles were checked. Sealing ring OK; bolt carrier group carbon buildup; firing pin difficult to remove.
1	FF-FBL	Semi-Automatic	5901	Rifle had to be gymmed by hand to load first round;
2	FF-FBL	Automatic	6401	rifle sluggish.
3	FF-FBL	Semi-Automatic	6501	
4	FF-FBL	"	6921	
5	FF-FBL	"	6961	
6	FF-FBL	"	6963	
7	FF-FBL	"	6964	
8	FF-FBL	Automatic	7081	
9	FF-FBL	Semi-Automatic	7121	
10	FF-FBL	Automatic	7241	
11	FFr-LI	"	8001	Light indent on all tracer rounds.
12	FFr-LI	Semi-Automatic	8102	Bolt carrier taken apart, carbon
13	FFr-LI	"	8105	buildup.
-	-	-	10000	Several days after test was completed, oblong insert in upper right cam path area found split in two.

TABLE A-6

FIRING TEST RESULTS

(COMPOSITE-LUBRICATED RIFLE NO. 5)

Malfunction Number	Malfunction Type	Type of Fire	Rounds Fired When Malfunction or Event Occurred	Remarks
-	-	-	1900	Because of broken sealing ring in Rifle No. 4, all composite rifles were checked. Sealing ring OK; bolt carrier group carbon buildup firing pin difficult to remove.
1	FF-FBL	Semi-Automatic	5901	Rifle had to be gymmed by hand to load first round.
2	FF-FBL	Automatic	6401	
3	FFr-LI	"	6881	
4	FF-FBL	Semi-Automatic	6901	
5	FF-FBL	"	7121	
6	FF-FBL	Automatic	7281	
7	FF-FBL	Semi-Automatic	7361	Used bolt assist.
8	FFr-LI	Automatic	7441	
9	FFr-LI	"	7461	Malfunctions 8 - 14 all on tracer rounds.
10	FFr-LI	Semi-Automatic	7501	
11	FFr-LI	"	7541	
12	FFr-LI	"	7581	
13	FFr-LI	Automatic	7861	
14	FFr-LI	"	8081	Bolt carrier taken apart; carbon buildup.
15	FFr-LI	"	8661	
16	FFr-LI	"	8681	After firing, bolt remained to rear.
17	FFr-LI	Semi-Automatic	8941	
18	FFr-LI	Automatic	9094	
19	FFr-LI	"	9095	Rifle taken apart, oblong composite in upper right cam path area broken out.

TABLE A-7

FIRING TEST RESULTS

(MIL-L-46000-LUBRICATED RIFLE NO. 6)

Malfunction Number	Malfunction Type	Type of Fire	Rounds Fired When Malfunction or Event Occurred	Remarks
1	FFr-LI	Automatic	3501	Gun sluggish, bolt gymmed by hand 10 times, then fired OK.
2	FFr-U	Automatic	6501	Would not fire in automatic mode. Taken apart (except bolt assembly). No parts replaced. Finally Fired OK.
3	FFr-U	"	6502	
4	FFr-LI	Automatic	6703	Carbon did not allow firing pin to 'go home'. Bolt taken appart, carbon buildup, firing pin difficult to remove; cam pin did not traverse completely.
5	FFr-LI	"	6705	
6	FFr-LI	Automatic	7901	Rifle taken out of test after 7904 round. Bolt had carbon buildup to the extent that firing pin had to be pounded out to disassemble bolt.
7	FFr-LI	"	7904	

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Evaluation of Lubricating Compoments for the M16A1 Rifle

Prepared By: George P. Murphy Jr.
Bernard J. Bornong

Technical Report R-TR-77-013

Pages, Incl Illustrations Tables
DA Project 1J662604H97, AMS Code 662604.11OH9702.02

A previous firing test made on one M16A1 rifle indicated that a combination of self-lubricating composites applied to the bolt carrier group and a solid-film lubricant coating applied to the upper receiver tracks could reduce malfunctions and maintenance time as compared with conventional lubrication. A follow-up test was carried out with five composite-lubricated rifles and one MIL-L46000A lubricated rifle as a control. The composite inserts, though slightly different in shape, were placed in the same areas as for the original test. The test on the five composite-lubricated rifles had an average of six malfunctions to with one in the original test. Three of the rifles were terminated before 10,000 rounds because of the fracture of the inserts. In one of these rifles the bolt sealing ring insert broke; this action caused the sealing ring to break. In the other two composite-lubricated rifles removed from test, the inserts in the cam path area fractured and fell out because, when the insert hole was machined, it broke through the cam path wall. The impact of the cam pin against the exposed portion of the insert eventually caused cracking. Nevertheless, these tests have demonstrated the feasibility of the use of the self-lubricating inserts. However, care must be exercised to insure that the inserts fit properly and are backed up with sufficient high-strength material.

1. Self-Lubricating Composites
2. M16A1 Rifle Firing Tests
3. Weapons Malfunctions
4. Weapon Firing Rate
5. Lubrication

I. George P. Murphy Jr.
Bernard J. Bornong
II. Rock Island Arsenal
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